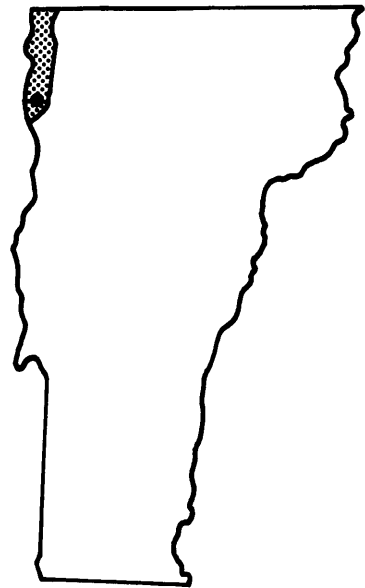


FLOOD INSURANCE STUDY



**TOWN OF SOUTH HERO,
VERMONT
GRAND ISLE COUNTY**



D E C E M B E R 1977

**U.S. DEPARTMENT of HOUSING & URBAN DEVELOPMENT
FEDERAL INSURANCE ADMINISTRATION**

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index

Flood Insurance Rate Map

Panels 500226 0001B - 0020B

FLOOD INSURANCE STUDY
TOWN OF SOUTH HERO,
GRAND ISLE COUNTY, VERMONT

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the Town of South Hero, Grand Isle County, Vermont, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert the Town of South Hero to the regular program of flood insurance by the Federal Insurance Administration. Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain management.

1.2 Coordination

Community base map selection and the identification of areas requiring detailed study were accomplished in meetings attended by personnel of DuBois and King, Inc., the Federal Insurance Administration, the South Hero Board of Selectmen, and the South Hero Planning Commission on April 22, 1976.

Water-surface elevations and study methods for wave analyses were coordinated at a meeting with other contractors studying Lake Champlain on November 10, 1976. Regional drainage area-frequency-discharge relationships used for the approximate study areas in the Town of South Hero were coordinated with those used elsewhere in the state by Anderson-Nichols and Company, Inc., the Vermont Highway Department, and Dufresne-Henry, Inc. Additional information on future conditions was coordinated with the Vermont Environmental Protection Coordinator, District #6.

During the course of the work by DuBois and King, Inc., flood elevations and flood boundaries were reviewed with community officials and with officials of the State Department of Water Resources. On August 2, 1977, the results of the work by DuBois and King, Inc. were reviewed at a final coordination meeting attended by South Hero town officials, and personnel of DuBois and King, Inc. and the Federal Insurance Administration; the study was accepted.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by DuBois and King, Inc. for the Federal Insurance Administration, under Contract No. H-4007. This work, which was completed in June 1977, covered all significant flooding sources affecting the Town of South Hero.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the chartered Town of South Hero, Vermont. The area of study is shown on the Vicinity Map (Figure 1).

The areas studied by detailed methods were selected with priority given to all known flood hazard areas, areas of projected development and proposed construction until January 1982.

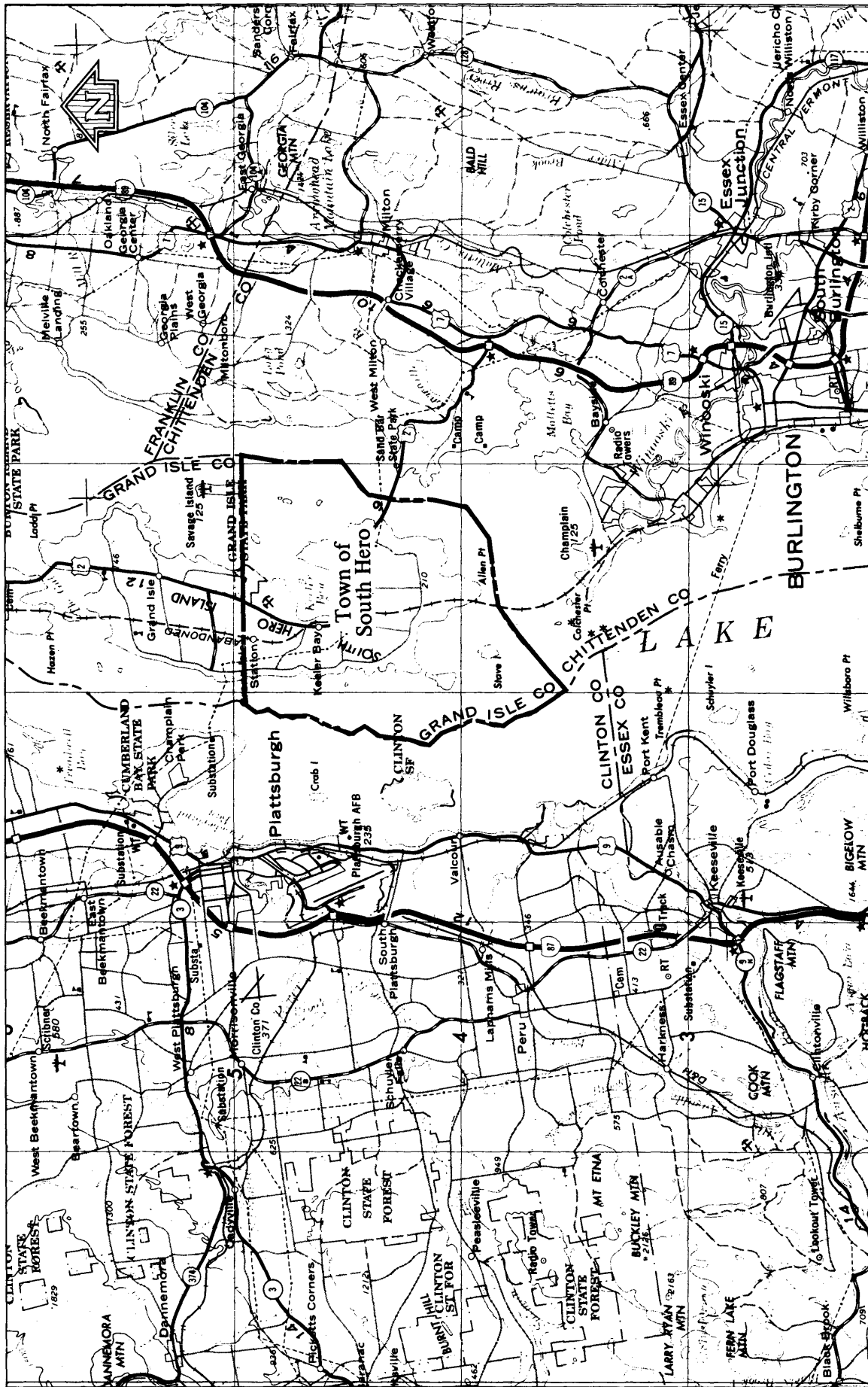
Approximate methods of analysis were used to study those areas having low development potential and/or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the Federal Insurance Administration.

The Town of South Hero has developed around the shores of Lake Champlain. Because of this development, it was agreed that the shore of South Hero Island would be studied in detail. Flooding on four small, unnamed brooks was studied by approximate methods.

2.2 Community Description

The Town of South Hero, located in Grand Isle County in northwestern Vermont, lies on the southern half of South Hero Island in Lake Champlain. The area which now encompasses South Hero, Grand Isle, and North Hero was given to Ethan and Ira Allen on October 27, 1779, as a reward for their services to the state. The islands were originally named Two Heroes Islands but by 1788 they came to be called North Hero and South Hero. The first settlers, Ebenezer Allen and Alexander Gordon, came by boat in 1783. Early economic development centered around agricultural products and the harvesting of timber. Today, the lands of South Hero are used primarily for agriculture, dairying, and apple orchards. The island is a very attractive place for resorts and thus attracts many summer tourists.

In 1975, the year-round population of the Town of South Hero was 1,000. The population varies greatly between summer and winter seasons, but it has been increasing at a slow rate and there is no major new development under



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Federal Insurance Administration

TOWN OF SOUTH HERO, VT (GRAND ISLE CO.)

APPROXIMATE SCALE



VICINITY MAP

FIGURE 1

way in the town. South Hero has a total area of about 42.3 square miles and a land area of 13.2 square miles, which is predominantly open agricultural land. The terrain is relatively flat and slopes gently to the shores of Lake Champlain. The maximum relief in the town is less than 200 feet. The shore of the island ranges from low flat swamps to high rocky cliffs. Much of the shore is low cliffs or gently sloping areas which are subject to high water and severe wave action. The soils of South Hero are grouped into two major associations. In the lower elevations, the soils are generally loamy, wet, stony, and deep. The soils in the higher areas are generally loamy, excessively to moderately well drained, and stony or rocky. Because the primary source of flood damage is Lake Champlain, the inland topography, soils, and vegetation have a minimal effect on flooding. The climate is characterized by cool summers and cold winters which are typical of northern New England. Normal summer temperatures are in the low 70's and winter temperatures can go well below zero. Precipitation over the area averages over 32 inches per year.

Lake Champlain has a total area of 490 square miles, composed of 435 square miles of water-surface area and 55 square miles of islands. The total area of the watershed, including the lake area, is 8,234 square miles, of which 7,705 are in the U.S. and 529 are in Canada. Lake Champlain empties into the St. Lawrence River through the Richelieu River, which flows north from the Canadian border.

The Town of South Hero shares South Hero Island with the Town of Grand Isle, which occupies the northern half of the island. Surrounding towns on the shores of Lake Champlain include Colchester and Milton, Vermont to the east; and Plattsburgh and Peru, New York to the west.

2.3 Principal Flood Problems

Coastal areas of South Hero are subject to periodic flooding caused by high water levels in Lake Champlain. Historically, the highest lake levels have occurred in the months of March through May. The ten highest recorded lake levels (and the frequency interval of each) occurred in 1869 (167-year), 1896 (33-year), 1903 (50-year), 1933 (13-year), 1936 (33-year), 1939 (13-year), 1969 (10-year), 1971 (17-year), 1972 (33-year), and 1976 (33-year).

One of the highest recorded levels of Lake Champlain occurred in April 1976. High waves accompanying the high water caused most of the flood damage in the Town of South Hero. Shore erosion was the most common damage. A few camps, boathouses, and garages were damaged or destroyed by the waves and accompanying shore erosion.

The 100-year flood levels are shown in Figures 2 through 4 for selected locations along the shoreline.



FIGURE 2 - 100-year flood elevation (without waves or run-up) at the western end of Sand Bar Bridge, looking east. The 500-year flood is 0.3 feet higher.



FIGURE 3 - 100-year flood elevation (without waves or run-up) near RM 27, looking south. The 500-year flood is 0.3 feet higher.



FIGURE 4 - 100-year flood elevation (without waves or run-up) at a location 2000 feet north of the Town of Keeler Bay, looking south. The 500-year flood is 0.3 feet higher.

2.4 Flood Protection Measures

Some landowners have built stone or concrete walls, more for prevention of erosion than for protection of structures. There is also one breakwater to protect the marina at the South Hero end of Sand Bar Bridge. There are no structures designed to provide general flood protection. Many of the camps near the shore are raised above the level of the 100-year flood.

The Town of South Hero regulates development in flood hazard areas and in the shoreland areas. Zoning regulations are based on models set by the state, requiring flood proofing of buildings by raising floors above the 100-year flood elevation (102 feet). The shoreland area extends inland 500 feet horizontally from the mean water elevation of 95.5 feet. Flood hazard areas are designated on the Flood Hazard Boundary Map for South Hero (Reference 1).

3.0 ENGINEERING METHODS

For flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10-, 50-, 100-, and 500-years have been selected as having special significance for flood plain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the streams.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak lake level-frequency relationship for floods of the selected recurrence intervals.

The lake elevation-frequency relationship is based on lake levels recorded at Burlington, Vermont U.S. Geological Survey (USGS) Gage #042945 (12 miles south-southeast of South Hero) and Rouses Point, New York Gage #042950 (24 miles north-northwest of South Hero). Analysis of these records by the engineering firm of Camp, Dresser and McKee for the Flood Insurance Study for the City of Plattsburgh (Reference 2) produced the lake elevation-frequency relationships (Table 1). At a meeting between representatives of the Federal Insurance Administration and Study Contractors, it was agreed to use these levels for the northern portions of Lake Champlain and that these levels should include wind tide and seiche effects. The lake elevation-frequency data are found by applying the Beard Method (Reference 3) to the annual peak level of Lake Champlain as measured at Rouses Point from 1869 to 1976. The mean water elevation of the lake is about 95.5 feet National Geodetic Vertical Datum of 1929 (NGVD).

TABLE 1 -- LAKE CHAMPLAIN ELEVATION-FREQUENCY DATA
(WITHOUT WAVE OR RUN-UP HEIGHTS)

<u>Frequency-Interval</u>	<u>Water Surface Elevation</u> (Ft. Above NGVD)
10-Year	101.01
50-Year	101.76
100-Year	101.97
500-Year	102.32

The following methods were used to define discharge-frequency data for the approximate studies: (1) Peak Rates of Runoff for New England Hill and Lowland Areas (Reference 4); (2) National Cooperative Highway Research Program Report 136, Experiment E-2 (Reference 5); and (3) "Discharge Index Slope" method of determining low frequency flows (Reference 6).

3.2 Hydraulic Analyses

Analyses of wave heights and run-up are carried out to provide estimates of the height of run-up for each of the selected recurrence intervals along the shore of the Town of South Hero.

Cross section data above the shoreline of South Hero were obtained by photogrammetry. The near shore bathymetry was obtained by field measurements.

Wave heights and run-up were analyzed by methods presented in the Shore Protection Manual (Reference 7). Deep-water wave heights were calculated using wind speed-duration data from Burlington, Vermont for the months of March through May 1976. The highest recorded stage of Lake Champlain at Burlington, Vermont occurred in April 1976. No wind speed-frequency analysis was made because wind speeds are independent of lake levels and because superposing a low probability wind speed on a low probability lake level results in an extremely low probability wave height. Deep-water wave heights were calculated using the Sverdrup-Munk-Bretschneider (SMB) diagrams (Reference 7). The wind speed-duration data for Burlington, March-May 1976, were superposed on the SMB diagrams, thus defining a maximum deep-water wave height for a given effective fetch length for the expected wind conditions.

The maximum deep-water height of waves breaking at the shore was estimated from the geometry of the surveyed sections and methods presented in Reference 7, considering both refraction and breaking of the waves. Run-up was then estimated based on the maximum deep-water wave height which could reach the shore using methods presented in Reference 7. Run-up heights ranged from 115.5 NGVD near Sawyer Bay to 102.1 NGVD at

a peninsula in Keeler Bay near South Hero. Wave run-up elevations at selected points are shown in Table 2.

TABLE 2. RUN-UP ELEVATION DATA

<u>Location</u>	<u>Run-up Elevation 100-year Flood (Feet Above NGVD)</u>
Rockwell Bay	109.5
1350 Feet South of Rockwell Bay	104.6
Peninsula North of Sawyer Bay	115.5
Barnes Bay	103.9
McBride Bay	108.8
Jackson Point	106.0
Phelps Point	102.9
Near RM 9	104.7
Near RM 12	107.1
Near RM 13	109.7
Near RM 15	103.5
Near RM 18	106.2
South of Sand Bar Bridge	102.4
Near RM 21	108.6
Paradise Bay	103.9
Near RM 22	115.3
Kibbie Point	106.4
Near RM 27	102.1
Community of Keeler Bay	106.0
Near RM 28	105.1
Hoyt Bay	102.4

The hydraulic analysis only considered conditions of wind-driven waves for open water conditions. Ice problems including wind-driven ice were not studied.

Flood boundaries along the approximate study areas were determined for the 100-year flood only. Flood depths and widths were estimated using normal depth as computed by Manning's equation.

All elevations are referenced from National Geodetic Vertical Datum of 1929 (NGVD); elevation reference marks used in the study are shown on the maps.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the Federal Insurance Administration as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For the shoreline, the boundaries of the 100-year and the 500-year flood have been delineated using the lake level from Table 1 without wave or run-up heights. The flood boundaries were delineated using topographic maps developed by photogrammetric techniques at a scale of 1:2400, with a contour interval of 5 feet (Reference 8).

In cases where the 100-year and the 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The boundaries of the 100-year and 500-year flood boundaries are shown on the Flood Insurance Rate Map. Small areas within the flood boundaries may lie above the flood elevations, and, therefore, not be subject to flooding; owing to lack of detailed topographical information or to limitations of the map scale, such areas are not shown. Additional approximate flooding areas on several unnamed tributaries and swamps have been added from the Flood Hazard Boundary Map (Reference 1).

Flood boundaries are indicated on the Flood Insurance Rate Map (Panels 0001-0003). On this map, the 100-year flood boundary corresponds to the boundary of the areas of special flood hazards (Zone A2); and the 500-year boundary corresponds to the boundary of areas of moderate flood hazards (Zone B).

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the Federal Insurance Administration has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors, and flood insurance zone designations for each flooding source affecting the Town of South Hero.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface

elevations between the 10- and 100-year floods. This difference does not have a variation greater than 0.5 foot for more than 20 percent of the reach.

One reach on Lake Champlain, meeting the above criteria, was required for the Town of South Hero.

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is the Federal Insurance Administration device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their Flood Hazard Factors are used to set actuarial insurance premium rate tables based on Flood Hazard Factors from 005 to 200.

The Flood Hazard Factor for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest one-half foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the Flood Hazard Factor is 005; if the difference is 1.4 feet, the Flood Hazard Factor is 015; if the difference is 5.0 feet, the Flood Hazard Factor is 050. When the difference between the 10- and 100-year water-surface elevations is greater than 10.0 feet, accuracy for the Flood Hazard Factor is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective Flood Hazard Factors, the entire Town of South Hero was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods, no base flood elevations shown or Flood Hazard Factors determined.
Zone A2:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones assigned according to Flood Hazard Factors.
Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood,

including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water control structure; or areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot. Zone B is not subdivided.

Zone C: Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, Flood Hazard Factors, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of South Hero is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the locations of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the Federal Insurance Administration.

6.0 OTHER STUDIES

In August 1976, the U.S. Department of Housing and Urban Development published a revised Flood Hazard Boundary Map for the Town of South Hero, Vermont (Reference 1). This map only contains approximate flood boundaries; no other flood studies have been conducted in this community.

A Flood Insurance Study has been substantially completed for the City of Plattsburgh. The lake levels without wave action presented in this report match those in the report for the City of Plattsburgh.

This report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the National Flood Insurance Program.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic and other pertinent data used in this study can be obtained by contacting the office of the Federal Insurance Administration, Regional Director, 15 New Chardon Street, Boston, Massachusetts 02114.

FLOODING SOURCE	PANEL ¹	ELEVATION DIFFERENCE ² BETWEEN 1.0% (100-YEAR) FLOOD AND			FLOOD HAZARD FACTOR	ZONE	BASE FLOOD ELEVATION ³
		10% (10-YEAR)	2% (50-YEAR)	0.2% (500-YEAR)			
LAKE CHAMPLAIN REACH 1	0005,0010 0015,0020	-0.8	-0.2	0.3	010	A2	102

¹ FLOOD INSURANCE RATE MAP PANEL

² WEIGHTED AVERAGE

³ ROUNDED TO NEAREST FOOT

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Federal Insurance Administration

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FLOOD INSURANCE ZONE DATA

LAKE CHAMPLAIN

TABLE 3

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